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ABSTRACT

An educational program on family resource management was evaluated to judge the goodness of fit of multiple regression equations for predicting program results across multiple sites. The applicability and effectiveness of the 11-lesson MONEY SENSE program was evaluated in six California locations for 190 clients. Indicators of effectiveness were: (1) change in frequency of financial problems; (2) change in self-perception of financial status; (3) change in average weekly food cost per person; (4) food consumption index score; (5) change in percentage of food shopping skills used; and (6) change in percentage of money management skills used. The 16 situational variables posited as influential were concurrently entered into two regression equations (restricted and unrestricted) for each of the outcome measures, and the validity of the two models was assessed. The analysis illustrated the use of a technique for determining whether the unrestricted equation (one specific to a subset) or the restricted equation (a regression equation for all members of a set) represents a better fit. In the example, the fit of the unrestricted equation was superior for three outcome measures, supporting the intuitive understanding that application of a curriculum in multiple locations does not mean that the program operates identically in all locations. Six tables provide study data. (SLD)

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JUDGING THE GOODNESS OF FIT OF A MULTIPLE REGRESSION EQUATION FOR PREDICTING PROGRAM RESULTS ACROSS MULTIPLE SITES

Joan Wright

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JUDGING THE GOODNESS OF FIT OF A MULTIPLE REGRESSION EQUATION FOR PREDICTING PROGRAM RESULTS ACROSS MULTIPLE SITES[1]

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Background

A question of interest in a number of program evaluations is how/whether the outcomes attributed to a program are related to characteristics of the program and participants, including ethnicity, gender, and the nature and extent of their involvement in the program. Increasingly, this question is important not just as a consideration for program improvement, but in concern for compliance with affirmative action. For example, are the impacts of a program on non-Anglos equivalent to those experienced by Anglos? Do persons who remain in a program for six months learn more than those who leave after three months? Is the mix of ingredients (e.g. participants, context, exposure) at one program site equivalent to that of another in terms of impact on participants? It is this latter question that prompted the analysis described in this paper.

The Program Evaluated

An educational program on family resource management (MONEY SENSE) has been conducted by Cooperative Extension staff and trained volunteers in multiple locations in California. Money Sense is comprised of 11 lessons, including units on goal setting, budgeting, record-keeping, banking, use of credit, meal planning and food shopping, savings and investments, insurance, and planning for major purchases. Its delivery strategy is to train volunteer Money Sense Advisors, who then "pay back" their training by sharing Money Sense content with others. Each Cooperative Extension Home Economist who chooses to use Money Sense as part of the county's educational program adapts it to fit the particular situation, e.g. the potential clientele and volunteers, incentives for participation, cooperating agencies. In the three years of its operation prior to this study, Money Sense has been used with many clientele groups, including teen-aged foster children participating in Social Services' "Independent Living Program," welfare recipients enrolled in California's GAIN (Greater Avenues to Independence) workfare program, tenants in public housing projects delinquent in rent payments, families served by an Indian Health Center, and low-ranked enlisted personnel at a military installation. Each group that has been involved with Money Sense has, in effect, been exposed to its own variation of Money Sense. Adaptations were made, for example, in the number and focus of lessons used, the Money Sense Advisors recruited, the use of small group or one-on-one instruction.

The Evaluation

With funding from the state Cooperative Extension system and California's Expanded Food and Nutrition Education Program, a statewide impact study of Money Sense was conducted (Wright & Varcoe, 1989). The evaluation examined the applicability and effectiveness of Money Sense in the six locations where it was used. The number of clients from whom follow-up data were obtained ranged from 21 in Humboldt County to 60 at Edwards Air Force Base, for a total of 190. Only the analysis of relationships between client/program characteristics and measures of program effectiveness will be discussed in this paper.

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[1] ~~Presented~~ Prepared for presentation at the annual meeting of the American Evaluation Association, October, 1989, San Francisco.

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Six indicators of program effectiveness were derived from interviews with Money Sense (MS) clients one to three month following their completion of the program:

Change in frequency of financial problems - Respondents were asked whether they thought they had financial problems before they enrolled in Money Sense, and if so, how often (e.g. weekly, monthly, occasionally). The question was repeated for now, after Money Sense.

Change in self-perception of financial status - Interviewers asked MS clients what they considered their financial status to be before MS and currently. Responses ranged from "poor" to "excellent."

Change in average weekly food cost per person - For families of limited means, one area in which it is possible to reduce spending is for food. Respondents were asked how much, on the average, they spent for food eaten at home before the MS program, and how many persons that fed. Then they were asked how much they spend now. Per person weekly food costs for pre-MS and now were calculated by dividing the amount specified by the number of persons. The now cost was subtracted from the before-MS cost to yield the amount of change.

Food Consumption Index score - Spending less money for food is not good resource management if the family's food consumption patterns do not reflect good dietary practices. To determine whether MS clients had adopted desirable dietary practices, a food consumption index was calculated for each client. Persons were asked whether, compared to before they started Money Sense, they now eat more or less of 15 different foods (e.g. milk/cheese, vegetables, candy, potato & tortilla chips).

Change in Percentage of Food Shopping Skills Used - Interviewers read a list of food shopping skills (e.g. do you make a list of the foods you need to buy before going to the store?). After each, respondents were asked if they do it now after MS, and if they did it before MS.

Change in Percentage of Money Management Skills Used - Similarly, percentages of applicable skills used now and before-MS were calculated for a list of money management skills. Change was represented by the difference between the two percentages.

Sixteen variables available from follow-up data were posited as potentially influential on the extent of change among Money Sense clients:

Time in the Area (TIMEAREA): The length of time an individual/family has lived in an area may affect the resources available and accessible to enhance family resource management.

Marital Status (MARITAL): It was assumed that married persons have more resources to contribute to family resource management than single persons, and that persons who are divorced/separated/widowed have less stable resources to contribute than single persons.

Number of Money Sense Lessons Completed (NOLESSNS): Presumably the more exposure the client has had to Money Sense, the more positive outcomes can be expected.

Whether the Client Developed a Budget as Part of Money Sense (MSBUDGET): One interviewer noted that persons who actually wrote out a spending plan as part of the program seemed to have made more changes in the number of skills used than those who talked about but did not prepare a budget.

Employment Status (EMPLOY): Employment was considered to be a source of family/individual stability, with full-time employment better than part-time.

Number of Earners (NOEARNRS): More contributors to household income were considered better than less.

Monthly Income per Household Member (MOINC): The higher end of the respondent's income bracket was divided by the number of persons in the household to provide a rough estimate of per capita income.

Number of Persons in the Household (NOWNUM): The number of persons fed in the household now was the indicator of household size. This was considered to be important apart from its effect on per capita income because of the extra management responsibilities involved with increasing household size.

Average Weekly Food Costs Prior to Money Sense (PREFOOD) and Income (INCOME):
These variables were included in the equation because it was believed that they might have an effect independent of their use in the calculation of weekly per person food costs and monthly income per household member respectively.
Age (AGE): It was assumed that the effect of age on family resource management is linear (i.e., younger persons are less experienced than older ones in managing income and household). This, of course, may not be an appropriate assumption, since some older persons may find their capacity to manage a shrinking income is diminished.
Percentage of Food Shopping Skills Used Before Money Sense (PSHNDX):
Percentage of Money Management Skills Used Before Money Sense (PSKNDX):
Perceived Financial Status Prior to Money Sense (PRESTAT):
Frequency of Money Problems Prior to Money Sense (PREPROB):
Weekly Per Person Food Shopping Costs Before Money Sense (PWKFDCST):
These variables, indicators of the MS client's resource management skill and status prior to involvement in the program, can be expected to influence the client's ability and motivation to make changes in family resource management. Among other things, a high score on any of the pre-MS measures puts a ceiling on the amount of change that can be made.

Analysis

The sixteen variables posited as potentially influential on the extent of change among Money Sense clients were concurrently entered into two types of regression equations for each of the outcome measures:

1. A restricted equation where the influence of each explanatory variable was forced to be the same for all locations; and
2. An unrestricted equation where the influence of each explanatory variable was allowed to vary across locations.

The restricted equations test the joint impact of the sixteen explanatory variables in all locations, by entering independent variable scores without attention to site. The unrestricted equations test the individual impact of the sixteen explanatory variables in each of the locations by creating independent variables that represent each of the 96 (16 x 6) site-variable intersections.

The validity of the two models was assessed with a technique borrowed from econometrics, the Seemingly Unrelated Regression (SUR) test for the accuracy of the restriction (Kmenta, 1986). This test produces an F ratio, which compares the variability in the restricted equation to the variability in the unrestricted equation. In this case, where the total sums of squares were not equal for both equations, the F ratio was calculated by comparing the R squares adjusted for degrees of freedom

$$\left[\frac{R^2_Q - R^2_K}{1 - R^2_Q}\right]\left[\frac{n - Q}{Q - K}\right] \sim F_{K,\,n-Q+1}$$

where K is the set of restricted regressors,
Q is the set of unrestricted regressors, and
n is the number of observations.

When the F is significant, one rejects the null hypothesis that the effect of each explanatory variable is the same across all sites. Instead of being "seemingly unrelated," the explanatory variables are actually unrelated across locations.

Results

Tables 1 through 6 show the direction of statistically significant ($p < .10$) predictors of change for both the unrestricted (site specific) and restricted (all sites) regression equations. Also shown are the F ratio, R square and adjusted R square for each equation, and the F ratio for the SUR goodness of fit test of the additional variables.

For three of the outcome measures, the fit of the unrestricted (site-specific) equation is better than that of the restricted equation. Changes in frequency of money problems (Table 1), in weekly per person food costs (Table 2), and in consumption of selected foods (Table 3) are better predicted on a site specific basis than across all sites. For the other three change measures--percentage of food shopping skills used, percentage of money management skills used, and perceived financial status--the restricted (all sites) equation is as good a fit (Tables 4-6).

TABLE 1. Direction of Significant (P<.10) Predictors in the Unrestricted (Site Specific)and Restricted (All Sites) Regression Analyses for Change in Frequency of Money Problems

	Site Specific						All
Variable	Hum.	DVC	Pla.	Stan.	Ven.	AFB	Sites
TIMEAREA	--	--	--	--	NEG	--	--
PSHNDX	--	--	--	--	--	--	NEG
PSKNDX	--	POS	--	--	--	--	--
PRESTAT	--	--	--	POS	--	--	POS
PREPROB	--	POS	--	POS	POS	POS	POS
PREFOOD	--	--	--	--	--	--	POS
NOLESSNS	--	--	--	POS	--	--	--
NOEARNRS	--	--	--	NEG	--	--	NEG
EMPLOY	--	--	--	--	--	--	POS
AGE	--	POS	--	NEG	--	--	--

F Ratio for restricted (all sites) regression equation: 10.67347, sig. .0000
R square = .57544 Adjusted R square = .52152
F Ratio for unrestricted (site specific) regression equation: 3.98379, sig. .0000
R square = .87900 Adjusted R square = .65836
F Ratio for SUR goodness of fit test: 1.85, d.f. 16, 52, sig. .0488

The frequency of money problems before Money Sense (PREPROB) is a significant predictor of change in frequency of money problems in four of the locations (i.e. the more frequent the pre-Money Sense problems, the more change was made), but there are other significant predictors unique to some of the counties. For example, for clients of the Domestic Violence Center, a decrease in frequency of money problems was positively related to the percentage of money management skills (PSKNDX) clients had used prior to Money Sense. In Ventura County, the less time the clients (mostly military) had lived in the area (TIMEAREA), the more change they experienced in the frequency of money problems.

Changes in weekly per person food costs were better predicted on a site-specific basis than by the restricted equation (Table 2). In four locations the amount of money per person spent for food before Money Sense (PWKFDCST) was a significant predictor. The more spent, the greater the change was likely to be. In three sites, the lower the percentage of food shopping skills used before Money Sense (PSHNDX), the more the change (i.e. savings) in per person food costs after Money Sense.

TABLE 2. Direction of Significant (P<.10) Predictors in the Unrestricted (Site Specific) and Restricted (All Sites) Regression Analyses for Change in Weekly Per Person Food Costs

	Site Specific						All
Variable	Hum.	DVC	Pla.	Stan.	Ven.	AFB	Sites
TIMEAREA	POS	--	POS	POS	--	--	--
MARITAL	--	--	POS	--	--	--	--
PSHNDX	NEG	--	--	NEG	--	NEG	NEG
PWKFDCST	POS	--	POS	POS	--	POS	POS
NOLESSNS	POS	--	--	--	--	POS	--
AGE	--	--	--	--	POS	--	NEG
MOINC	NEG	--	--	--	--	NEG	--
PSKNDX	--	POS	--	--	NEG	--	--
NOWNUM	--	--	POS	--	--	POS	POS
INCOME	POS	--	--	--	--	NEG	--
PREFOOD	NEG	POS	--	--	--	--	NEG

F Ratio for restricted (all sites) regression equation: 16.52579, sig. .0000
R square = .67726 Adjusted R square = .63628
F Ratio for unrestricted (site specific) regression equation: 8.52073, sig. .0000
R square = .93953 Adjusted R square = .82927
F Ratio for SUR goodness of fit test: 3.68, d.f. 16, 52, sig. .0002

The equations predicting change in consumption of selected foods vary significantly among the six Money Sense sites (Table 3). Two variables are significant in more than two locations; one, percentage of food shopping skills used before Money Sense (PSHNDX), is negatively related to change in food consumption patterns in three sites. That is, the fewer pre-Money Sense food shopping skills used, the more improvement in consumption of selected foods after Money Sense. The number of Money Sense lessons completed (NOLESSNS) is a significant predictor of change in food consumption patterns in four applications; however, the direction of the relationship differs among these locations.

TABLE 3. Direction of Significant (P<.10) Predictors in the Unrestricted (Site-specific) and Restricted (All Sites) Regression Analyses for Change in Consumption of Selected Foods

	Site Specific						All
Variable	Hum.	DVC	Pla.	Stan.	Ven.	AFB	Sites
PWKFOCST	--	--	--	--	NEG	--	--
PSHNDX	--	--	--	NEG	NEG	NEG	--
PREPROB	--	--	--	--	NEG	--	--
PREFOOD	--	--	--	--	POS	--	--
NOWNUM	--	--	--	--	NEG	POS	POS
NOLESSNS	POS	--	POS	--	NEG	POS	POS
NOEARNRS	--	--	--	POS	--	--	--
MSBUDGT	--	--	--	--	POS	--	--
MOINC	--	--	--	--	POS	--	--
MARITAL	--	--	--	--	POS	POS	--
EMPLOY	--	--	--	NEG	--	--	--
AGE	--	--	NEG	--	--	NEG	--

F Ratio for restricted (all sites) regression equation: 1.86038, sig. .0302
R square = .19109 Adjusted R square = .08838
F Ratio for unrestricted (site specific) regression equation: 2.11465, sig. .0020
R square = .79407 Adjusted R square = .41856
F Ratio for SUR goodness of fit test: 2.27, d.f. 16, 52, sig. .0135

TABLE 4. Direction of Significant (P<.10) Predictors in the Unrestricted (Site-specific) and Restricted (All Sites) Regression Analyses for Change in Percentage of Food Shopping Skills Used

	Site Specific						All
Variable	Hum.	DVC	Pla.	Stan.	Ven.	AFB	Sites
PWKFDCST	--	--	--	--	--	POS	--
PSHNDX	--	NEG	NEG	NEG	NEG	NEG	NEG
PREFOOD	--	--	--	--	--	NEG	--
NOWNUM	--	--	--	--	--	POS	POS
NOLESSNS	--	--	--	--	--	--	POS
NOEARNRS	--	--	--	--	--	--	POS
AGE	--	--	--	--	--	--	NEG

F Ratio for restricted (all sites) regression equation: 13.77865, sig. .0000
R square = .63632 Adjusted R square = .59014
F Ratio for unrestricted (site specific) regression equation: 3.18398, sig. .0000
R square = .85062 Adjusted R square = .58346
F Ratio for SUR goodness of fit test: .85, d.f. 16, 53, n.s.

As indicated in Table 4 the use of the site-specific model does not improve the goodness of fit of the regression equation for change in percentage of food shopping skills used. The main predictor across all sites is the percentage of food shopping skills used before Money Sense (PSHNDX). The fewer skills used before, the greater the gain.

TABLE 5. Direction of Significant (P<.10) Predictors in the Unrestricted (Site-specific) and Restricted (All Sites) Regression Analyses for Change in Percentage of Money Management Skills Used

	Site Specific						All
Variable	Hum.	DVC	Pla.	Stan.	Ven.	AFB	Sites
TIMEAREA	--	--	--	--	NEG	--	--
PSKNDX	NEG	NEG	NEG	NEG	NEG	NEG	NEG
PREPROB	--	POS	--	--	--	--	--
NOLESSNS	--	--	NEG	--	--	--	--
MSBUDGET	--	--	--	--	--	--	POS
MARITAL	--	--	POS	--	--	NEG	--
EMPLOY	--	--	--	--	--	--	POS

F Ratio for restricted (all sites) regression equation: 46.36177, sig. .0000
R square = .85480 Adjusted R square = .83637
F Ratio for unrestricted (site specific) regression equation: 9.06162, sig. .0000
R square = .94188 Adjusted R square = .83794
F Ratio for SUR goodness of fit test: .82, d.f. 16, 53, n.s.

The site-specific equation predicting change in percentage of money management skills is not significantly better than the restricted (all sites) model (Table 5). In all cases, the greater the percentage of money management skills used prior to Money Sense, the less change was likely to be made--a kind of ceiling effect.

TABLE 6. Direction of Significant (P<.10) Predictors in the Unrestricted (Site-specific) and Restricted (All Sites) Regression Analyses for Change in Perceived Financial Status

	Site Specific						All
Variable	Hum.	DVC	Pla.	Stan.	Ven.	AFB	Sites
TIMEAREA	--	NEG	--	--	--	--	--
PSHNDX	NEG	--	--	--	--	--	NEG
PSKNDX	NEG	--	--	--	--	--	--
PRESTAT	--	NEG	--	NEG	NEG	NEG	NEG
PREFOOD	--	--	--	--	--	--	POS
NOEARNRS	POS	--	--	--	--	--	--
MSBUDGET	NEG	POS	--	--	--	--	--
MARITAL	--	NEG	--	--	POS	--	POS
INCOME	--	POS	--	--	--	--	--
EMPLOY	NEG	--	--	--	--	--	--

F Ratio for restricted (all sites) regression equation: 12.53105, sig. .0000
R square = .61409 Adjusted R square = .856508
F Ratio for unrestricted (site specific) regression equation: 2.63710, sig. .0001
R square = .82506 Adjusted R square = .51220
F Ratio for SUR goodness of fit test: .55, d.f. 16, 52, n.s.

The site specific (unrestricted) equation is not a better fit than the all sites (restricted) equation in predicting perceived financial status (Table 6). While there are other statistically significant predictors of change in perceived financial status, the major influence is the financial status perceived before Money Sense (PRESTAT). The lower the pre-Money Sense estimate, the greater the change in perception of financial status.

Discussion

This example has some obvious limitations. The six locations included in the analysis served very different clientele populations, both within the location and among locations. The descriptive variables employed in the regression are those that were available and that could be made to fit the regression framework, not necessarily those that best described the learner population and the learning situation. The total number of Money Sense clients from the follow-up data have been collected is only 190, limiting the degrees of freedom available. The outcome measures are mastery levels, not levels on a scale with upper limits which few could attain. Perhaps most important, the example was initiated without clear appreciation of the uniqueness of each individual client's learning experience.

Nevertheless, it does illustrate the use of technique for determining whether an unrestricted (i.e. a regression specific to a subset) equation or a restricted (i.e. a regression for all members of a set) equation represents a better fit. In this example the fit of the unrestricted regression equation is better than that of the restricted equation for three of the outcome measures--change in frequency of money problems, in weekly per person food costs, and in consumption of selected foods. This supports the intuitive understanding that the application of a specific curriculum in multiple locations does not necessarily mean that the same "program" is operating in each location. That is, one expects that the combination of clientele, nature and extent of exposure to the curriculum, the teacher, and the conditions surrounding the learning experience will vary considerably across locations.

In this analysis of Money Sense experience, however, the influence of some explanatory variables across all sites was especially pronounced for three of the outcome variables--change in percentage of food shopping skills used, in percentage of money management skills used, and in perceived financial status. In each case the learner's pre-treatment score on the outcome measure was the single most significant predictor of gain. The higher the pre-Money Sense score, the less the gain, probably an artifact of the mastery measure used.

Use of single restricted equation for all locations can lead to inappropriate ideas as to what constitutes a program, and to inaccurate views regarding the relationships between program inputs and outcomes. Use of a single restricted equation for each location does not permit the cross-location (or other subset) analysis that is offered by the SUR technique.

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